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Japan's Critical Issues on IT Human Resource

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1 New sort of crisis

Since the 1960's, it has been repeatedly said of "IT engineer shortages for a certain number of people and the necessity of strengthening the IT industry". The government has kept investment in IT businesses and IT related departments were booming for the universities and the number of IT engineers also increased thanks to the efforts of half a century.

However, nowadays people more often talk about the shortage of IT engineers, which is now called 'IT human resources crisis'. The authors have studied this crisis in the industry and government and have visited acitivities which have taken to overcome the crisis. Although we have not completed our study, we have come to understand that this crisis is not just an issue for one industry sector but the issue of entire Japan. However, only a few people recognized the issue as a 'crisis'. This ignorenceitself is critical. This paper is to report the result of the study of this 'crisis' and "the efforts which have been made to overcome the crisis" as well as to offer a proposal for new solutions.

2 Nature of the new crisis

The current crisis has a difference from the ones in the past. Previous 'crises' were not 'real crises', as the past cases had more luxurious concerns based on "human resource shortages caused by market expansion". However, the current issue is not such a 'benign crisis' but a 'real crisis' in which Japan could go into decay due to the lack of IT human resources.

On January 18, 2008, Hiroko Ota, the minister in charge of economic and fiscal policy, stated at the national diet that Japan's economy is no longer in the first-class. The mass media, coincidentally began to talk about the 'decay' of the country and society.[1,2] It seems as if most Japanese people are beginning to accept the possibility that the Japanese economy, which held the position as the second largest economy for a long time, would be surpassed by other economies such as China sooner or later. The current crisis is the one at the time when Japanese economy has a sign of being weakened and it is more serious than that when it was said that this is the 'era of the Japanese economy to expand' or the 'Japanese economy was still strong'. This is a 'genuine crisis', in which the shortage of advanced IT human resources could accelerate the decay of Japan to the point where it will not be able to compete against other industrialized countries.

On the other hand, the acknowledgement of this 'real crisis' has brought about the possibility of the forming of a national action instead of the separated and limited actions taken so far to overcome the crisis. In particular, the Keidanren (Japan Federation of Economic Organizations), which had been quiet on the issue, has started to actively approach academia and government. In response to this, MEXT (Ministry of Education,culture,sports,science and technology) is leading the way for universities to review their IT education curriculums. Traditionally, industries did not interfere the academia and accept the students as-is to foster them within the company. This is even true for Japanese IT industries because most of their engineers are from humanities courses other than IT specialized courses. However, this is beginning to change. METI, MIC and MEXT tended to act individually in the past, while the Cabinet Secretariat IT Strategic Headquarters is now beginning to take the lead, which is a notable

change.

Governments of the US, India, South Korea, and China have been making efforts to develop human resources of advanced level IT engineers in cooperation of industry-government-academia. Japan lags behind and is currently at the stage where some activities have just begun to take shape. The current 'crisis' is not just an issue for IT industry but also the national issue of the social infrastructure like food and energy issues which could have a significant affect on the entire society. Thus, an appropriate counteraction should be taken immediately. Section 2-1 explains how this crisis is serious.

2-1 IT system as nervous system of society and industry

On December 20, 2007, the Third Meeting for Industry-Government-Academia Cooperation on Advanced Information and Communication Human Resource Development (hereafter the 3rd meeting for industry-government-academia cooperation)[3] was held at the Keidanren Hall in Otemachi, Tokyo. Many speakers participated in the meeting including Fumio Kishida, the Minister of Science and Technology Policy and many other parties concerned from the industry, government and academia. Osamu Dairiki (Chairman, the Strategic Project Team on Advanced Information and Communication HR Committee of the Keidanren Information and Communication Committee) was especially the one to prominently state the significance of the crisis. Dairiki said that information is the "nervous system of industries in the 21st century" and these 'nerves' are in danger.

The Japanese industry is still strong. However, according to Dairiki's rhetoric, it will become a "giant without a nervous system" unless using the power of IT. No matter how powerful the muscles and bones may be, the body will not function without a nervous system. In the October 2006 issue of Science and Technology Trends,[4] the authors predicted and pointed out that all industries would depend upon IT eventually. As a result of this, the weakness of the Japanese software industry could 'seep' into all industries and there is a risk of the decrease of competitiveness of all Japanese industries. The issue of the 'nervous system' mentioned by Dairiki corresponds to this 'seeping phenomenon'.

During the era of mainframe computers, software was just an "accessory" for hardware. The focus then shifted to software, and then to the Internet. IBM, the world's largest hardware manufacturer around that time, has sold many of their hardware departments such as their PC division to Lenovo. Meanwhile, they rapidly strengthened its consulting and service facilities. IBM, which used to be an accounting machines manufacturer, is now the second largest software company next to Microsoft as of 2007. They also started to focus on their business towards 'services' such as consultancy.

One of the articles of ITmedia, the IT news website, explained IBM's service science[5] as follows: the era is ending where technological invention in product development was competitive. It is now generally accepted that a comprehensive service combining various solutions are the key to be competitive, such as the combination of business strategy, management science, social science, cognitive science, legal science, industrial engineering and so forth.[6]

In an era that it was difficult to create hardware, hardware was the key of IT business. However, as high-performance hardware became common, software took that place. As it is now easy to "write a complicated program", the critical issue is shifted to "design" the services of software. This change is similar to auto industry, where the emphasis has shifted from the engine performance to the "design for usability according to the users' lifestyles".
IT systems including the Internet are drastically changing the organizations in such fields as communications, finance, sales, advertising, government, education and entertainment. As a result of this, the competitiveness of products which at least relate to social activities is now depending on the quality of the services provided by, relating to, and wrapped around the product, not the product itself.[7]

If a service is 'physically intangible' such as a mailing service, it would be provided by IT systems. Even if it is a 'physically tangible' service such as the courier service to deliver parcels, an advanced IT system is necessary to support the function. The current courier system is a typical model of socio-techno system, which is realized by the IT systems consisting from electronic devices

and the humans who use them and function as a component based on a predetermined protocol, where various IT technologies are deployed such as the logistics systems, WEB, GPS, mobile phones, and QR codes. With such a courier service, the delivery personnel keep delivering parcels while receiving instructions from the center though mobile phones. In reality, it may be the 'information' called 'parcels' are transferred from one place to another by the hand of the delivery personnel which behaves as part of the system according to orders given by the system. Courier companies are now the IT company, where IT is the key to their quality of services. Likewise, almost all industry sectors have started to use IT. This is the 'seeping phenomenon' the authors stated in the October 2006 issue of Science and Technology Trends.[4] Therefore, the 'nervous system for the industries in the 21_{st} century' as Dairiki mentioned is now used in all industries based on IT.[Note 1]

2-2 Human resources for top management in the era of Integration of IT and company management

IT technology, which was once a means to replace the existing human-systems with automated systems, has been transformed into the general-purpose technology to create new 'socio-technology systems for innovation' to innovate economic competitiveness.

Therefore, the first class IT personnel to create the future are required to make the maximum innovation available with the basic resources (hardware, software, human resources, social and corporate systems) and propose the optimum way to realize it while considering positive effects in the society, which is quite different from an entry-level ability just to copy a 'task protocol clearly defined' to a program. This innovative capability is a skill, which would be supposedly required for top management who make a strategy for organizations and companies.

In other words, this means that the potential of innovation would increase if top management within organizations or groups understands the significance of IT. It should be considered that IT is now a requirement of top management, in addition to the knowledge of politics, law, economics and corporate management as well as sociology and psychology.[7] IT capability has become a basic human ability like language, and plays an important role in the field of 'social science' which covers most of human activities, just like mathematics in physical science.

If there is a shortage in human resources who can handle such an important 'tool' called IT, the consequence is clear as crystal. Unfortunately, this shortage is already real so that this crisis is quite serious. The reality is more complex as there are also shortages in mid and lower-level human resources such as program managers and designers. There are opinions that these levels of human resources could be outsourced offshore as explained in 4-1 and 4-2. American companies are now deploying such a strategy. According to this opinion, the shortage of mid-level human resources is not so critical, but the shortage of top-level resources is very serious.

However, a crisis can also be an opportunity. In the September 2004 issue of Science and Technology Trends,[8] the authors pointed out that the agile method (agile software development method) which is currently one of the most cutting-edge technologies in IT, has its root in Japanese style production and management such as Toyota's production system. If IT and corporate management are to merge in the realm of innovation, there is no reason to think that Japan's proven ability to create a 'Japanese style of production and management',[9] which have changed the world a few decades ago, would work out once again. The driving force behind Nintendo's recent comeback was the new corporate policy[10] set out by the market and technologies insights of Satoru Iwata, the president, who was a programmer (graduated from Information Engineering Department, Tokyo Institute of Technology). As this example suggests,

[NOTE 1]
This is a book published by Yukio Noguchi and Satoshi Endo,[26] at the final stage of editing this report. The authors referred IT as a 'general purpose technology' or 'technology that can be used beyond the boundary of industries as well as for various purposes', which changed the world economy and society. This is almost the same view as ours.

Japan does have top-level resources. Therefore, it may not be impossible to turn this crisis into an opportunity.

3 Actions for a new era; trends of foreign countries

The current 'human resource crisis' is caused by changes in the social position of Information Technology. Such changes are obviously not only taking place in Japan but also all over the world. Topics such as globalization, flattening, Web2.0, etc., show that they are various aspects of the huge change of the social system. It may be natural that the United States, at the forefront of IT, has accommodated the changes and have strategies and policies to take advantages of the change. India, South Korea, China and Germany also have recognized such large-scale social changes and have taken actions for the human resource development. The activities in these countries are explained based on data from the Keidanren and MIC.[11,12] Then, we will introduce the most advanced establishment for human resource development, the Stanford University d.school from the viewpoint of IT human resources to bring about innovation as discussed in 2-2.

3-1 Advanced IT human resource development in the World - Focusing on the United States -

In the United States, universities have a high level of autonomy. IT human resource development has been a task of individual universities, groups of universities, academia and business organizations. The United States has been successful in developing a large number of qualified IT personnel and furthermore attracting IT personnel from rest of the world. The Council of Competitiveness is a NGO, which compiled the so-called 'Palmisano Report'[13,14] and coined the word 'service science'. In the United States, the industry, government and academia are spontaneously cooperating for human resources development.

In the federal government, chief information officers (CIO) are assigned in the government agencies under the Clinger-Cohen Act of 1996. The CIOs voluntarily formed CIO Council, which became a government organization and now operates the CIO University, a virtual CIO development institution. This "national university for training government officials" is open to anyone, and their graduates will also become CIOs in business organizations.

In business world, US educational institutions boast of the revolutionary IT engineers and founders of major companies including Microsoft, Apple, Yahoo and Google. Not a few of them were dropped out of college or graduate school. The Stanford University Department of Computer Science, which is regarded as "research-oriented, little education", has been the alma mater of many advanced IT human resources including the founders of Google. US has been successful to nurture advanced IT human resources, and as a next step of the evolution, US is now trying to develop highly innovative human resources as in Stanford's d.school.

In India, which is the major offshore outsourcing destination for the United States, the Ministry of Human Resource Development and NASSCOM (National Association of Software and Service Companies), a group of business organizations, are making joint efforts as reported in the September 2007 issue of Science and Technology Trends. [15] As the IT industry in India is evolving at a tremendous speed, Indian companies may have the chance to gain the major role of development, which currently tend to subcontrac American or Japanese companies.

China and South Korea are now emphasizing on IT human resource developments as a national policy, even though IT industry does not take the big share of their economy as India. Information and Communication University (ICU) in South Korea, and Chinese Software Institution (in 35 major universities) are the representative examples. In Germany, where the overall situation is more similar to Japan than that of India or China, the similar type of human resource development are underway to foster advanced IT engineers at the Hasso Plattner Institute (HPI) at the University of Potsdam, which was established through a donation by Hasso Plattner, one of the founders of SAP.

The HPI at Potsdam has a sister school, HPI d.school at Stanford, which we currently consider as the most advanced IT human resource development institution.

3-2 HPI d.school at Stanford and T-shaped people

In the United States where IT industry is one of their competitiveness, a new type of human resource indispensable for business is widely discussed. While the given names of this type of people vary widely, the common characteristics is the capability of being expert and generalist at the same time. As depicted in Figure 1, the cross-boundary knowledge of such people as a generalist is shown as a horizontal bar while the specific knowledge as an expert is shown as a vertical bar, so that we call them 'T-shaped people' because of the shape of the two characteristics is like 'T'. There are arguments that having one area of expertise is not enough, but they should be π-shaped people with at least two areas of expertise. Putting names aside, the idea is spreading that innovations created by T-shaped and π-shaped people, will be the source of the future competitiveness,[16] so that this is the basics for our view mentioned in 2-2.

In fact, the concept of T-shaped people has a tradition in Japanese companies which expect their employees to be both generalist and expert. The 'multi-skilled worker' concept in the Toyota production system incorporates several vertical bars. However, this old concept is now discussed as if it is a new concept in relation to IT and innovation.[16,17] How could this be?

Although the T-Shaped people discussed now are similar to the old T-Shaped people, these are different in nature. In terms of old T-Shaped people, represented by multi-skilled workers, they obtain some expertise such as mechanical or electronics engineering first, which is represented by the vertical bars, then 'additionally place' a horizontal bar on the top to create the T shape. It could be said that the emphasis was on the 'multiple vertical skills'. The horizontal bar was supposedly representing skills to be acquired on site, not through the education in universities. It is also regarded as a matter of personal development.

However, the current T-Shaped people, regardless of their educational process,[NOTE 2] are 'those who have the horizontal skill, and by using this horizontal skill, spontaneously extend their new vertical skills according to the needs at each point of time.' The horizontal bar is not what the individuals develop themselves through the years but something taught as 'meta-skills' to attain at the early stage of their personal career in educational institutions such as the d.school at Stanford University. Tim Brown explained T-Shaped people as follows:[16]

" We look for people who are so inquisitive about the world that they're willing to try to do what 'you'do. We call them 'T-Shaped people'. They have a principal skill that describes the vertical leg of the T -- they're mechanical engineers or industrial designers. But they are so empathetic that they can branch out into other skills, such as anthropology, and do them as well. They are able to explore insights from many different perspectives

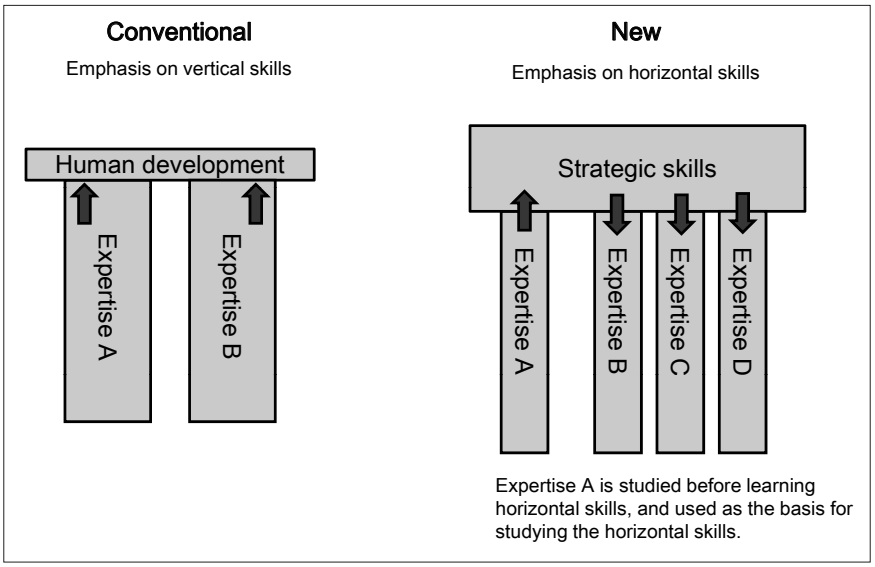

Figure 1 : Conventional and new T-shaped/Π-shaped people

Prepared by the STFC

and recognize patterns of behavior that point to a universal human need. That's what you're after at this point -- patterns that yield ideas."

The 'you' as above is one as a top management of a company or a leader of a development team. The T-Shaped people mentioned above are not the top-level management personnel but human resources at the next level down who assist the top management. However, T-shaped people are necessary in a wide range of levels from the top management to the middle class or above personnel. Whatever the case, it is not easy for us to acquire the ability of T-Shaped people and the number of those who has this ability would be limited.

In the United States, many universities are beginning to establish courses for foster such T-Shaped people. One of these schools is HPI d.school at Stanford University. This educational institution was established by donations from Hasso Plattner, which was the same case as HPI in Germany. The official name is Hasso Plattner Institute of Design at Stanford, which is commonly referred to as d.school.

HPI in Germany is a school for training IT human resources in the conventional sense, in which they teach software production methods.[NOTE 3] However, HPI in the United States is not. d.school is part of the Mechanical Engineering Department and one of the founding members is David Kelly, a famous designer and innovator as well as the founder of IDEO a design company.

The authors visited the d.school at Stanford in March 2008 and observed the session called "Agile Aging" by Professor Terry Winograd, who is one of the major members of d.school. He is also a famous IT researcher who pioneered the concept of the importance of 'design' in IT[18,19] and promoted this concept in the mid-80s.

While the session has a fixed timetable, the students and lecturers would come and leave as necessary. During the session, the participants discuss, assemble prototypes, and listen to visiting lecturers who are active designers or entrepreneurs. They even interviewed elderly people to find out the meaning of an "agile old-age life", which is the theme of this "Agile Aging" session. Such activities take place concurrently in various parts of the large room by four to five teams consisting of three to four people. There were five to six lecturers acting in various ways, some working with a team, and some moved from team to team like Professor Winograd.

The students have different fields of expertise and come from different departments. They learn the horizontal bar skill of T-Shaped people. Attending the project that develops a technology for an "agile old-age life" does not mean that the objective of the participants is social welfare. This is just an example for attaining the skills of the horizontal bar. In fact, items that we found on the whiteboards and memos in the large room of d.school were all about a structure of ideas, interaction of humans, and products and humans. In other words, the core target of this session is 'a process to generate ideas' common to many fields, not the knowledge of expertise such as programming, telecommunication or welfare. (Specific knowledge represented by the vertical bar would be available at each department).

Regarding the modern software engineering, the significance has become relatively low in tasks involved in writing programs nd running them, thanks to the advancements of hardware, tools and methodologies. On the other hand, system 'designs', as saying of Professor Winograd, has gained more significance including the requirement development at the upstream beyond programming and modeling. Under these circumstances, the most important issue in IT system for engineers is to gain an abstract understanding of the relation between things within the environment (the real world surrounding the system) and design the structure, layout and interface with environment of the system in order to allow the system to achieve the maximum effectiveness.

[NOTE 2]
It is difficult to obtain the horizontal skills from the beginning. It should be reasonable to have one vertical bar first and place the horizontal bar, then create other vertical bars below as related to the horizontal bar as a process of learning.

[NOTE 3]
Information on the application for the program is available at http://www.mext.go.jp/a_menu/koutou/it/index.htm

The skills needed for this purpose are surprisingly similar across the various fields such as mechanical engineering, system engineering, production engineering, business administration, and software engineering. This is 'to learn the patterns in generating ideas' of Brown. In terms of IT, 'the common pattern' is particularly important since its physical entity is vague or none. In other words, the computer that was once the essence of IT is now just one of the many 'technical areas'. Now, the very essence of IT system development is what is common among these areas. This is the reason why IBM goes into the business beyond software. This is also the reason why IT authorities like Professor Winograd and Hasso Plattner (also a lecturer of d.school) are working on nurturing T-Shaped people at d.school, rather than at a software educational institution.

The number of skills for vertical bars can be infinite. It is difficult to predict which vertical bar should be used to obtain 'the most optimum answer' for a project to achieve the objective, because there are wide variety of combinations of options and the speed of innovation is so fast. Therefore, the appropriate skill of the vertical bar may keep changing even in the course of the project.

Under such conditions, the most important skill is the horizontal bar of T to attain the necessary skill at its necessity because as it is not possible to prepare the ability beforehand. Due to the 'seeping phenomenon', this applies to many 'fields of expertise', including IT.

This means that the T-Shaped people in the field of so-called 'Information Technology arena' need to be 'information engineers' as well as to surpass the limitation of 'IT'. This is what we mean by the 'advanced IT human resources'. The top-notch field of the world requires this type people, and in fact, the action is taken to 'nurture' such human resources.

It seems almost impossible to bring forth such perfectly capable people. This is not education in the conventional sense but 'nurturing'. The skills of the horizontal bar of the T-shape may be similar to what was stressed by Professor Erwin von Bälz, saying 'a spirit since the era of Greece which lies in the background and supports the various fields of science, that the students could not learn from lectures in the classroom, but can only learn directly from us (teachers from abroad)', who taught at the Tokyo Imperial University in the Meiji era (late 19th Century). The authors pointed this quotation out in the October 2006 issue of Science and Technology Trends.[4] Since such human resources are the key to the competitiveness, there is no choice but we nurture such people no matter how difficult it may be. Thus, d.school attempts to nurture T-shaped people by applying any methods that would be extraordinary from the ordinal educatio systems.

This 'nurturing system' is currently about to be transferred from the United States to Germany. In March 2008, d.school has also opened in HPI Potsdam. According to Professor Winograd, Hasso Plattner is concerned about the potential decline of German industry due to the lack of 'designing' abilities of engineers, therefore he established d.school in Germany to transplant the sense of 'design' that people of Silicon Valley possess. Hasso Plattner is attempting to transplant the 'design' spirit to Germany, after accumulating the know-how of nurturing people for a few years at d.school in Stanford.

4 Current situation in Japan

Japan has only started to make efforts to develop advanced IT human resources while the United State and Germany are gaining their experiences. As a matter of fact, the actions to produce general IT human resources are not sufficient in Japan. Most of the current arguments on IT human resource development have not addressed the target type of people, which have caused significant confusions. The following is the overview of the Japanese IT human resource development situation.

4-1 Japan lags behind: Shortages of mid-level human resources Worsen the case

There are various types of IT human resources. The advanced IT human resource is important but just one of many types. To bring forth the idea produced by advanced IT human resources into reality, we need various types of people sharing and cooperating towards the goal . For example, the concept should be converted into a strategy, then into a project, then broken down into a set

of programs, or sometimes turned into design and development of new hardware, and then proceed to the practical operation. Moreover, as the technologies vary from enterprise system like e-commerce to real-time embedded system like automobile engine control, the task may be divided on separate domains. Thus, the types of IT human resources are highly diversified. The needs of the society determines the type and the numbers of human resources required. The policies for human resource development depends upon the needs of Japan.

Nonetheless, not enough discussion and consensus have not been given for the IT people categorization, which further brought confusions. The first trial to categorize the types has appeared in the working group report on IT human resource development of METI in 2007 (Figure 2).[20]

Although we do not fully agree with this classification, we understand that this is a good starting point. According to this classification, the advanced IT human resources, whom we have been discussing, would be those who have the combined aspects of creativity and strategy making. We are afraid that, if these two types are considered to be different, innovation may not be brought in. Therefore, we concerned that this categorization could be a misleading with this report, however, we regard this report has provided an important platform to start with. Another working group report on ICT human resource development has recently been published by MIC.[12] It also contains important information that will contribute to the future discussions.

IT human personnel in general should be categorized as 'solution-oriented human resources' by the METI classification. The role of this type of people is to produce the system 'as requested' by the company/organization. This is a 'conventional' type of IT human resources, such as 'programmers', 'system engineers' , and 'project managers'. Ordinary people would imagine those type of people from the word 'IT human resources' .

However, they are not the type of people that we call 'advanced IT human resources', because they are in the mid -level in the aforementioned vertical task sharing. India has a large population of this type of people. When American companies

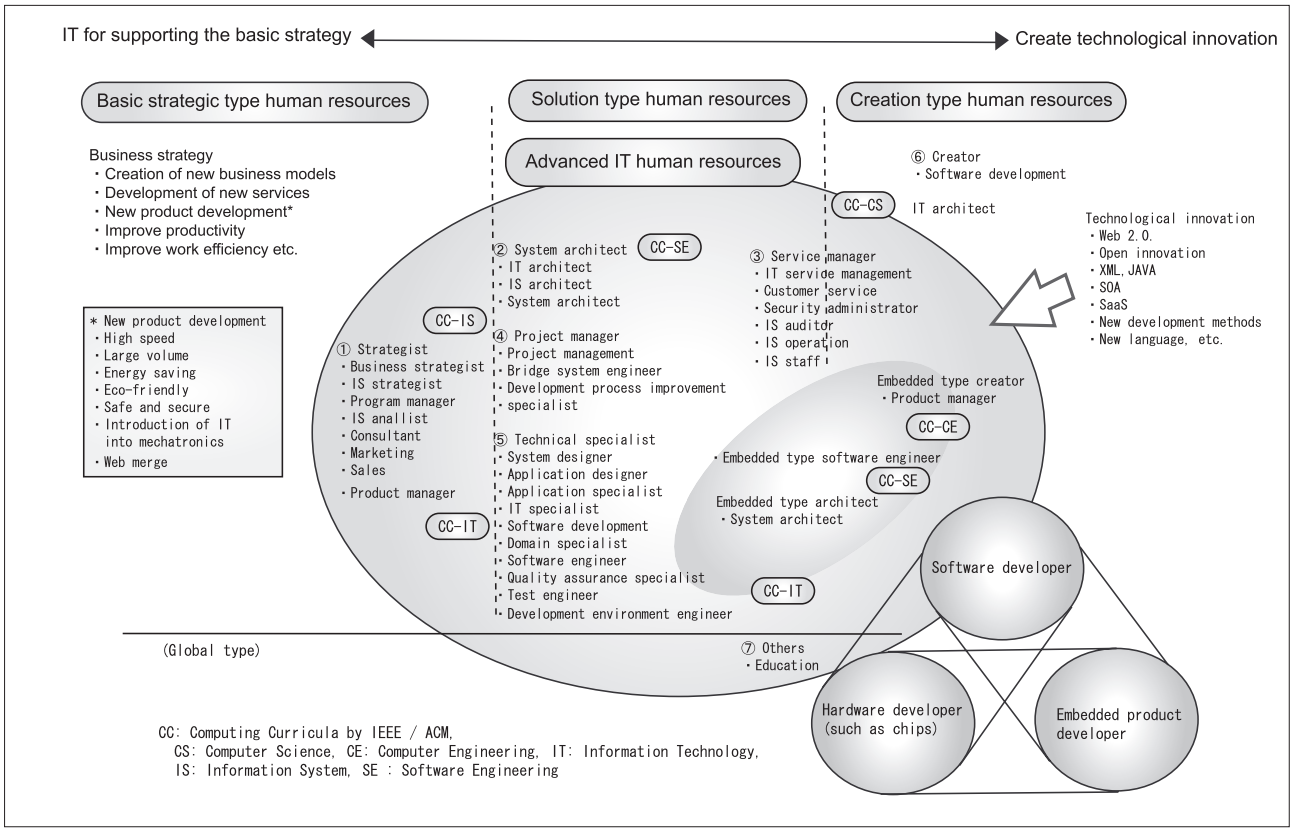

Figure 2 : Classification of the 'types of IT human resources' according to the study group by the Ministry of Economy, Trade and Industry[20]

Source: Reference[12]

see India as a place of offshore outsourcing of IT, it appears they are seeking this type of human resources. The United States, surpassing other countries in IT, are outsourcing these tasks offshore, because strategically these tasks are not so important. In fact, when discussing shortages of IT human resources in Japan, there are opinions that, "there is no need to do all tasks in Japan. Some can be handled by foreign engineers". This might be a reasonable opinion about the 'mid-level solution type human resources'. Offshore outsourcing is recently rapidly growing, partly because Japanese vendors can not meet domestic demands. This is referred to the end of 'national isolation policy of IT'.[21]

The manufacturing industry, which transferred many of its factories to overseas in 1980s and 1990s, may take the position that such 'overseas transfer' is inevitable for Japanese IT industry. However, a significant difference lies between IT and manufacturing industry, that is while manufacturing companies have products to sell overseas, IT companies, especially software companies are in 'regional industry' in the sense that the excess of imports at a rate of 100 to 1 except game software.[8] The increase of offshore outsourcing in this situation means that the Japanese IT industry cannot meet even domestic demands. This also strongly indicates that the level of Japanese IT industry is far below the global standard. In fact, there are many evidences for this fact as shown below,.

4-2 Japanese IT human resources below the global standard

The data and survey results, which explains the basis of Keidanren's working team on IT human resource development, have been published in 2007,[11] where Japanese IT human resources and its education system are indicated below the global standard. For instance, Japanese education system is criticized as no significant differences on the level of IT skills are observed between the various educational institutions, even from those who did not attend the higher IT education (Figure 3).

Furthermore, it was found that only 10% of newly graduates (20% in the case for those from IT-related departments) can start working without taking IT training at the company. Those who cannot qualify the IT job even after IT trainings are 22% of all, (16% of those from IT-related departments). Yamashita et al. point out that there is no significant difference between these 22 and 16 percent, which means that universities had failed to teach enough skills of IT.

The Keidanren team concludes that the cause lies in the curriculum and education methods in Japanese universities and pointed out the gap from the needs of IT companies, which is filled by foreign universities (Figure 4).

We need to be careful on these survey results. First of all, most of these numbers are based on self-assessment so that Keidanren team also admits the arbitrariness and lack of objectivity. Additionally, the curriculums of technical schools are supposed to satisfy the IT companies' needs, but Figure 3 indicates that there is no superiority in their graduates' skills, which may mean that the curriculum and education methods have no significance. It seems that more information is necessary to analyze the situation of IT education at Japanese universities.

However, we agree that 'on-the-job training are insufficient in Japanese universities due to its emphasis on research', which is reasonable from the authors' experiences in IT business and education in universities, and coincides our results from interviews. In fact, many educators in universities share the same opinion. The fact that practical IT education is insufficient in Japanese universities is undeniable.

In contrast, there is different opinion that it is important to teach the basic knowledge, not the practical skills and knowledge that are valid only

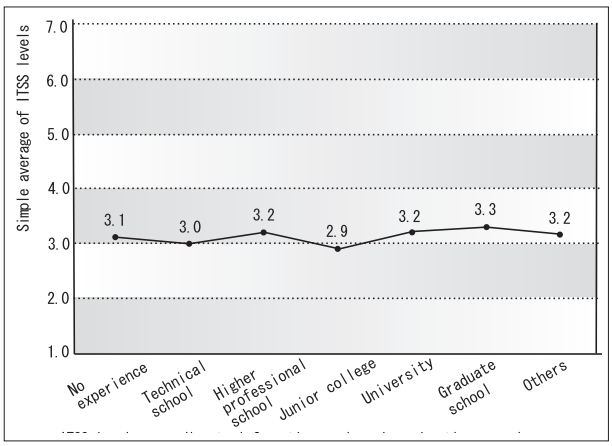

Figure 3 : Could IT education be useless?[11]

Source: Reference[11]

for short - time and narrow - region. In the top ranked universities, some says that the educational efforts are focused on competent students with excellent skills, while little attentions are paid to the rest who may become the mid-level engineers. If these kind of operations could have brought force enough number of high - level IT human resources, their basic research - oriented education might have no problems.

As a matter of fact, the Computer Science Department at Stanford University is known as being strictly research - oriented and providing little care for the students. However, the school has produced not only the world - class researchers but also some once - in - a - decade innovators such as Larry Page and Sergey Brin, Google founders as well as the number of advanced level people.

There should be no problem if the same thing happens in Japanese university. Unfortunately, it is not the case, even though several decades have passed since IT - related departments such as information science and computer science had been established in Japan. To make things worse, we hear that there are not enough young Japanese engineers who can qualify the global standard of global companies such as Google.

We interviewed some people in Google Japan and United States how they see Japanese young employees. Both Norio Murakami, CEO of Google Japan, and Manabu Ueda, the only Japanese manager of the Google headquarters in California, said that Japan is a large market for Google and they would like to hire Japanese engineers to respond the market. However, they cannot recruit enough number of students who qualify the requirements of Google. According to Mr. Ueda, Japanese students have no concrete answer to the question: 'Please explain what will you do to make a system like that'. Mr. Murakami added that he was surprised to see the newly hired graduates come from only the two laboratories of University of Tokyo

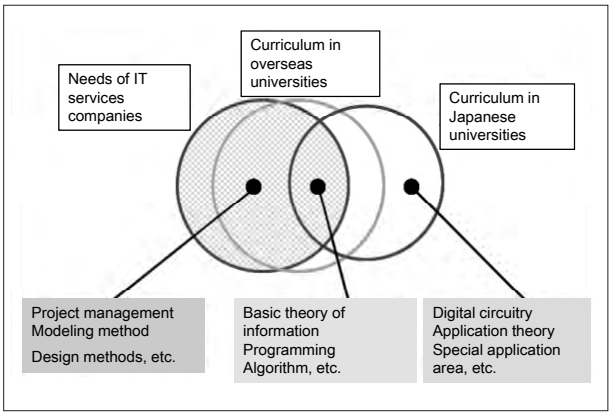

Figure 4 : Gap between IT engineering needs and education[11]

Source: Reference[11]

Yukako Uchinaga, a former executive of IBM, provides another case, who wrote in her article[22] that the 'skills survey' of the software laboratory in IBM Japan revealed the fact that Japanese new graduates need three years to reach the practical level, Level 3 (Level 5 is the best),while IBM laboratories in the United States and Israel observes that their new hires are qualified at the level 3.

According to IBM and Google, even the graduates from top-ranked Japanese universities fail to achieve the global level.

Based on the discussion in this section, we must say that Japanese IT education system is not functioning well to develop capable personnel at a practical level in almost all levels.

5 Advanced IT human resources development in Japan

The authors believe that actions should be taken by the society and government to overcome the issues of IT human resources. Therefore, it is worth mentioning the activities in these few years by METI, MEXT, and MIC in cooperation with the Cabinet Secretariat taking the lead, as well as the movements in private sectors such as Keidanren. This section will introduce some of the case studies that are significant for IT human resource development in Japan.

5-1 New course in graduate schools: efforts of MEXT and Keidanren

The ministries to supervise IT are METI, MEXT, and MIC. One of the characteristics of this new effort by the government for advanced IT human resource development is that the Cabinet Secretariat IT Strategic Headquarters is to coordinate the matters and lead the attempt as part of the so-called e-Japan strategy. The IT Strategic Headquarters is making the strategy, then METI, MEXT and MIC implement it. METI and MIC are focused on study groups with industry, and MEXT

executes the policy of human development.

What worth mentioning is 'IT Specialist Program Initiative' by the Technical Educations Division, Higher Education Bureau of MEXT. This program was launched in FY 2006. 6 schools (Tukuba, Nagoya, Osaka, Kyushu, Keio and 2-8 its associate schools) were selected out of 26 applications. In FY 2007, another program focusing in the field of security was open, and two groups were selected. For the first program, an annual subsidy of roughly 100 million yen per one operating base was granted during four years. For the second program, an annual subsidy of roughly 80 million yen per group was granted for the same period.

At each universities, the new course on different tracks than the conventional master's course was established, with the clear goal of producing competent IT human resources. The initial class began in FY 2007. Currently, the second year of education is taking place.

Among these schools, we visited the "Social Information System Engineering Course" at Kyushu University Graduate School, and "Specialized Program for Practical Software Development for Advanced IT Human Resources Development" at Tsukuba University Graduate School. There are other universities worth mentioning such as the efforts of Nagoya University Graduate School's 'On - the - job learning (OJL)' as a new cooperative program between industry and academia with the academia' s leadership The courses at the two operating bases that we visited are promoted by "Advanced IT and Telecommunication Human Resources Development Project" of Keidanren, and are considered as test cases for the future, because of the active involvement of the industry with academia, such as having lecturers dispatched with the support from Keidanren.

5-2 Case study of Kyushu University and Tsukuba University: cooperation of industry, government and academia

The status of new courses under IT Specialist Program Initiative varies at each operating base. However, the education systems in Kyushu and Tsukuba are similar because the curriculum were designed in advance by Keidanren human resource development team. The most significant characteristic is that Project Based Learning (PBL) by full-time lecturers dispatched by Keidanren-related companies play the key role in their education. The overview is given as below.

(1) The first year first term: Learn how to implement projects by using beginner level PBL materials.
(2) The first year second term: Implement PBL by designing the development project with real 'clients', such as private companies or university departments, who may actually use the results.
(3) Faculties act as project managers.

[Programming as a performance]

The authors stated that focal point of IT competitiveness is shifting from programming to design. However, Google the cutting-edge global IT company stresses the importance of programming as one of the key skills of their employees. This appears to have a contradiction. In fact, the programming ability is very important for a truly innovative system development. When you make revolutionary software that you have no idea of how to make it, it would be possible if you are a programmer and write a tentative program to try it yourself. This is the same thing as a composer who could play the piano for example. When a new tune comes to his mind, he can check it by actually playing the instrument. Google seeks revolutionary but practical ideas. It may be a beautiful new song. In a sense the employees are required to have the ability to play the music being able to support the ability to compose. Junya Kondo, CEO of Hatena Co., Ltd., which is known as a search engine venture business that originated in Japan, said in his blog that even a graduate from the School of Information and Mathematical Science, Faculty of Engineering, Kyoto University would fail Google's employment test. He assumed that this might be because of the lack of programming education at School of Information and Mathematical Science, Faculty of Engineering, Kyoto University, compared to the University of Tokyo.[25] The programming ability in this case may be referred to be the programming to support the creativity of the employees.

(4) 'Clients' and 'project managers' intentionally create 'difficulties and conflicts'.
(5) Placing emphasis on interactions with business people. For example, omnibus lectures are performed by instructors dispatched by companies, and organizing PBL results presentations to the attendance from outside.
(6) Establish a system that students participate in the curriculum improvement.
(7) Special working environment is provided including PC, self-study books, and laboratories.

While it is yet the second year of the program and is too soon to evaluate the whole results, some successful cases have already emerged such as patent applications and a move to adoption of electronic - key system at the university campus. Furthermore, some of the produced documents are in higher quality than those of the actual small-scale system development projects in the industry. These results should be highly appreciated considering the fact that the students have only six months of learning the development methods. It could be said that the results so far are fully satisfactory.

The success of these courses proved that Japan has potential human resources, and that with effective educational system will bring forth qualified people such as project managers for solution businesses as described in Figures 1 and 2.

5-3 Issues and potentials of the new course in graduate schools

Some of the issues for the new courses of the two universities are the followings:
(1) Is it possible to maintain the course even after the end of the IT Specialist Program?
(2) Can they maintain the current level of education for a long -time?
(3) Is it possible to port and expand similar programs to other universities?
(4) Can they further develop more advanced courses for top management level that are discussed in 2-2.

Concerning the continuity of the course raised in the issue (1), the condition of the application for the program stated: there should be a plan for a 10 year period, including the period to implement the program, and assuming that its self-reliant and productive operation after the end of the period, to receive the subsidies.[Note 3] So, there should have been some plans by participating universities. Furthermore, there were opinions from the Cabinet Secretariat IT Department that the program should be continued due to its importance. We expect the universities to make efforts, and the government to provide budgetary support in response to such efforts.

For items (2) and (3), serious issues remain unsolved. Both Kyushu and Tsukuba Universities fully depend on teachers from member companies of Keidanren, from maintaining PBL, lectures and exercises. This means that the universities alone cannot perform these courses.

It would be preferable if the companies would continue their support, because it enhances the cooperative relationship between the industry and academia. Under the global tough competition, Japanese industry has no luxury to give enough support for continue the program, not to say the nation-wide expansion. On the other hand, in the case of OJL at Nagoya University Graduate School, the faculties of the university mainly cover the education while maintaining the partnership with companies. Considering the scale of human resources required for Japan, the Nagoya case is more realistic. Meanwhile, there remain doubts whether there are enough lecturers in the existing universities to perform the PBL.

5-4 Implications from preceding cases

There is an important example of PBL in Future University - Hakodate, Hakodate City. This should be a clue to solve the problem of 'the faculties on active duties capable of PBL at the same level of Kyushu or Tsukuba Universities'.

Future University - Hakodate is a unique public university for engineering education by incorporating artistic aspects and their laboratories are called 'workshop'. This university applies PBL to the education of Grade 3 undergraduate students in the form similar to that of the new courses of the graduate schools in Tsukuba and Kyushu Universities.

At the beginning of their PBL programs, NS Solutions Corporation supported the program, who assists the new course of Kyushu University.

However, this program is now operated by the university faculties while still cooperating with the company. The significant characteristic of this university is that PBL is actively supported by both the president and faculties. They aware the positive effects of PBL, and they keep trying to make a fusion of PBL conventional education by biringing the achievements of PBL to the support for researches. This should be very important for the continuity of the current IT Specialist Program Initiative and its expansion throughout the country.

5-5 National center plan

Keidanren is proposing to establish National Center to support IT Specialist Program Initiative that are currently being performed at universities such as Kyushu and Tsukuba.[23] This is designed to make these efforts to be more stable and sustainable as well as to establish the nation wide program for IT human resource development. They also propose an integrated-type specialist graduate school. Specifically, National Center will function as follows.

(1) Researches for effective and practical IT education.
(2) Development and promotion of model curriculums
(3) Coordination hub for universities throughout Japan and its sponsor companies.
(4) Educational asset management
(5) Faculty Development

It is desirable for National Center to take full advantage of existing know - how such as - Kyushu, Tsukuba, Hakodate and so on. Management and faculties should visit the National Center graduate school to learn the know-how, or the Center should have a consulting system to support a construction of new education system. The nationwide activities for IT specialist development should come to realization with these supports by the National Center. This change of universities should solve the current issues of nurturing and education of middle class IT personnel. Technical Educations Division, Higher Education Bureau of MEXT is pursuing to implement the 'project for sophistications of teaching materials for the operating bases', which should be easily achieved by the establishment of National Center.

5-6 More advanced level IT specialist

National Center alone cannot the solve the issue (4) in 5-3. The PBL centered education like Kyushu and Tsukuba Universities can produce mid - level IT specialists such as project managers, but not for more advanced level of specialists such as CIOs, who are critically needed in Japan.

When we indicated this concern to Keidanren team, they responded that their targets include such higher level, and the current results are just from the first year experience. In fact, the omnibus type lectures at Kyushu University are similar to the CIO training in companies. One PBL project

Figure 5 : PBL presentation at Kyushu University

Prepared by Associate Professor Fukase, Kyushu University

'Clients' (from real companies) at the near side
(Tsukuba University Graduate School,
IT Specialist Program Initiative)

Figure 5 : Students interviewing 'clients'

Prepared by Professor Komatani, Tsukuba University

cooperates with engineers in Bangladesh for Grameen Bank. To find out such project, and to bring forth its design and implementation are what the more advanced specialists need to do. At this moment, the students are studying topics that are provided by the lecturerers, however, we would like to expect the students to find out and propose topics by themselves in the near future.

It is too soon to ask the education of corporate top management with the IT Specialist Program Initiative, which just started in its initial year. As mentioned earlier, T(Π)-Shaped people model and skills are not easy to achieve. The eventual results of IT Specialist Program Initiative will become clear only after the youth participating the course grow up and become the key players in the society. We hope to continue the survey to investigate the ourcomes of the program.

However, the world is changing rapidly, not waiting for us. It is too late to start the next action only after we get the final result of the new course. Therefore, we believe that National Center should provide more advanced-level IT specialists as well as the enhancement of the valuable experiments of current IT Specialist Program Initiative. We hope that the Cabinet Secretariat IT Strategy Division to take the lead on this direction.

5-7 Need of social changes: IT human resource problem as social issue

IT human resource issues can not be solved simply by the reform of academia. These issues are not just educational but socially structural in Japan. The ‘cause' and ‘effect’ are linked together in complex form and the ‘effect’ is producing the ‘cause’. Thus the problems cannot be resolved at ‘the place of production’ of human resources.

The current form of university education must have been good for the industries for a long time. Otherwise, the industries should have complained much sooner. As Yamashita, et al.[11] admit Japanese university IT departments have placed an emphasis on basic research because it matched with the needs of the industries until the collapse of the bubble economy. The companies had provided sufficient in-house training to their newly hired employees. Now, there are signs of change in this ‘practice’ such as the start of the ‘Public Private Partnership on Human Resource Development’ by METI and MEXT.

When university educations change, the companies and the society to receive the personnel should also change. The authors encountered an unforgettable case: one of the students of Kyushu University was so disappointed because he was told that the course he took is useless since it would be included in the company training. In PBL presentations at Tsukuba University, similar comments were given but the students strongly opposed to it. In the case of Future University - Hakodate, a student were disappointed that he got a job offer from a promising IT company but his parents hardly understand the value of what the company does. Even if the universities provide competent youth, the society and companies can easily spoil them if they do not change. When university educations for human resource development reform itsel, the companies and society should change accordingly. We hope that the start of Public Private Partnership of METI and MEXT is a symptom of such change.

For the development of advanced-level IT specialists to take solid root in Japanese society and to make Japan competitive in the global market in terms of innovation, the change of social structure is needed including laws and social practices. Who should play the key role in realizing such changes? Private companies should be important. Laws and legal system are also need to change. Nowadays, policies on science and technology are closely linked to the legal system. For instance, a new law was enforced to realize a new corporate model called LLC to support venture businesses in the United States and Europe. Research in mathematical economics revealed that innovations would hardly happen if the patent law is tightened. Google Print (Google Book Search) project to scan all the knowledge of the world, are hindered by the copyright law.

Advanced-level IT specialists are those who bring innovations. T(Π)-Shaped people should be capable to proceed political activities such as lobbying as part of their development project. While such people should be in the top management of companies, they should be politicians, government officials, or the top management of NGO and NPO. The authors believe that those who solve issues on advanced-level IT specialist shortage are in fact

advanced-level IT specialists themselves.

6 Proposal

The above discussed the serious issue of IT human resource development in Japan, and changes in the world that caused such issues as well as the measures taken by industry, government and academia in Japan to solve the issue. The following proposes the policies based on these conditions.

6-1 IT human resource development for survival as a developed country

In the United States as the most advanced IT country, we often see signs of a new form of IT which would exceed the conventional IT, in a limited sense, because of the development of new concepts such as service science and T-shaped people. It seems that the emerging countries of IT such as India, South Korea and China are not at the level. However, given the fact that they have established an industry-government-academia cooperation in human resource developments and follow the United States in the policies, it should be a matter of time that these countries would be capable at the same level of the United States.

In Japan, the conventional way of human development of IT personnel is not function well. It is even said of the end of the 'national isolation of IT due to the increase of 'offshore outsourcing' of IT jobs, which weakens small and mid-sized Japanese IT vendors. Although it would not be necessary to complete all IT procedures within Japan, other industries should also have a negative impact because of neglects to develop IT personnel in Japan if the discussion in 2-2 is correct. Even though Japan sees a difficulty to be competitive in IT industry, this country at least should make efforts to develop capable and advanced level IT personnel. In 1980s, Japan once aimed to be the leading country in IT as the fifth generation computer project. However, what we should do is not to be the top ranked country but to remain its position at the global standard.

Therefore, the development of advanced IT human resources is an urgent and high-priority issue of Japan. This should not be an issue to be separately considered by the academia, industry, or just one of the government agencies respectively. The advanced IT human resource development issue needs to be resolved as the highest priority issue for the government to take on immediately, otherwise it would affect the future of this country. The Prime Minister's Office should recognize this significance of this issue of advanced IT personnel shortage, as explained in this paper, as a national crisis and take a strong initiative to tackle the issue. In this sense, it is natural for the Cabinet Secretariat IT Division to take the leadership in the human resource development. Then, academia, industry and the pertinent government offices such as MEXT should play a practical role for human development in the field while following the initiatives of Prime Minister's Office.

6-2 New way of human resource development

It would be difficult to change Japanese universities drastically. If necessary, we should consider a new education system to be separated from the existing university system. One of the options is to privatize the graduate schools attached to the national center, as proposed by Keidanren to have more liberty in activities. In addition, the school should be branch school of American universities, which has been done in South Korea, so that the graduates would obtain the degree of the universities in the United States, not the degrees in the universities in Japan.

6-3 Teachers outside the conventional field of IT

The current deadlock may be immediately solved with a new idea of education system, not in the framework of the conventional educational systems. By expanding the concept of IT in the narrow sense and aiming to develop T-shaped people, teachers should not necessary be IT experts. For example, d.school in the United States is an educational institution of mechanical engineering and there are many lecturers from other fields such as industrial design. Thus, in the sense to foster a designer in a wide sense, not only IT, there should be quite a number of potential teachers in Japan.

If there are not capable teachers in Japan even with the new way of thinking, teachers can be invited from overseas, which may be a possibility to solve the teacher shortage issue

soon. For example, the graduate school attached the national center proposed by Keidanren could be established as a virtual university like CIO University, an educational institute of CIO for the US federal government. This can provide an opportunity to develop T - shape skilled personnel beyond the boundary of business, universities or even countries as tutors are available for capable students who wish to be have T - shaped skills. Approximately a hundred elite students, business people, government employees, and academics are to become the students of the graduate school in the national center. Their education will be entrusted upon outstanding lecturers, regardless of the organization that the lecturer comes from, whether it is a university, business organization, public research institution, government organization, and NGO, from within Japan or abroad.

Such a system as above may contradict with the conventional Japanese education systems, which may still be controversial. To overcome these hurdles will require the activities of the Prime Minister's Office, the political community and related government agencies that fully understands the current crisis, and the private companies and some universities supported by them.

6-4 Roles of companies

Keidanren is the most active organization in policies related to IT specialist development and influencing the parties around them. In the United States, South Korea and India, the 'industry' has a significant presence in the organizations for human resource development so that it is natural for Japan to have high expectations on the role of Japanese private companies. Therefore, the government should actively support and use Keidanren and its activities. Furthermore, Keidanren is also requested to 'be used' by the government by acknowledging the human resource development of advanced - level IT specialists is an important national project affecting the future prosperity of Japan in the next generation.

Currently, IT industry, especially the software, is often abandoned as '3K job' (KITSUI , KITANAI, KIKEN ; hard, dirty and dangerous in Japanese). Even though we could make a system of the human resource development for advanced IT specialists, the workplaces of the industry is not attractive to the capable young people. Some software engineers in the manufacturing industry even regrettably say that there is still a class system in Japanese manufacturing companies, as mechanics come first, and then followed by electric/electronics and software at the end. The entire Japanese society should taken some measures to improve the status of IT engineers, especially of the software industry, through the change of such mindsets or solving the issues in the multi-tiered subcontracting structure in the industry. Therefore, the industry should be at the center of the structure to tackle this issue, as they actually deal with such IT specialists. The authors strongly believe that the industry represented by Keidanren should take the lead on the reform of mindset of Japanese society and the reform of the industry structure. The government should then provide strong support on such activities of the private sectors such as Keidanren.

6-5 Needs to have advanced-level IT specialists for government, politics and media

The authors would like to point out one of the major concerns through the study of the concepts and proposals of Cabinet Secretariat, MIC, METI, MEXT and MIC and Keidanren as well as their human resource development programs as a collusion of this section, The target of human resource development in these concepts and programs is the private companies in most cases. There is little reference of human resource developments of CIO for the central and local governments, which is equivalent to CIO University in the United States. As discussed in 5-7, the shortage issue of Japanese IT specialist is a social problem so that we need people who really understand IT in the government organizations, and even in the legislature to make a fundamental solution. Journalists who have deep understanding of IT are also needed to write articles to help Japanese people to correctly understand the world of IT. Some IT related articles on the Japanese newspapers are incredibly low in quality, which may be because IT university graduates to find employment in the mass media. On the other hand, there are opinions that a certain number of people from the mechanical, electrical and electronics fields find their ways at journalism every year so

that the articles are reasonable in contexts. Hence, the advanced-level IT specialists should also be needed not only by the industry but also in the world of politics, government administration and mass media to seriously consider the future of Japan.

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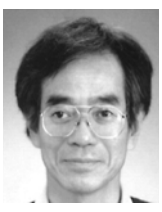

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